Diffusion-C

Unveiling the Generative Challenges of Diffusion Models through Corrupted Data

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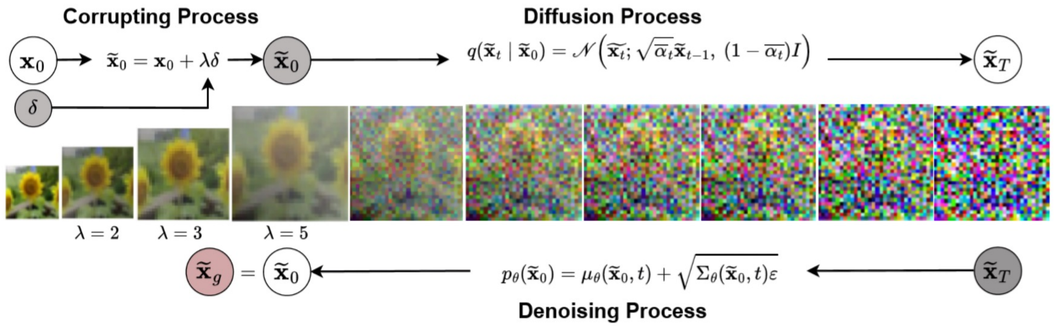
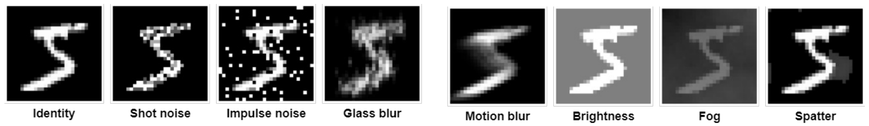


Corrupting process: $\tilde{\boldsymbol{x}}_0 = \boldsymbol{x}_t + \boldsymbol{\lambda}\boldsymbol{\delta}_k \; (1 \leq \boldsymbol{\delta} \leq 5)$

Metrics : $\mathcal{F}(\tilde{\boldsymbol{x}}_0, \tilde{\boldsymbol{x}}_g)$

- $\boldsymbol{x}_t$: original images
- $\boldsymbol{\lambda}$: severity of corruption
- $\boldsymbol{\delta}$: corruption
- $\tilde{\boldsymbol{x}}_0$: corrupted images
- $\tilde{\boldsymbol{x}}_g$: images generated by generative models
- $\mathcal{F}$: similarity between $\tilde{\boldsymbol{x}}_0$ and $\tilde{\boldsymbol{x}}_g$ (FID score)

Q1: if the original input is corrupted with corruptions (δ), can Diffusion Models still return quality images?



- Eight corruptions and GAN models (DCGAN, WGAN-GP) as a comparison of Diffusion models (DDPM, DDIM).

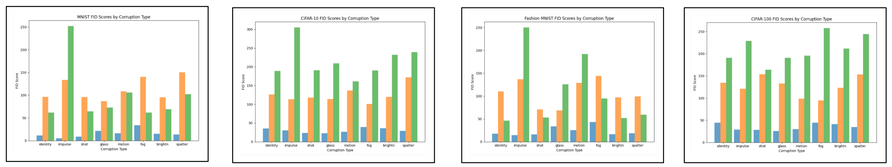


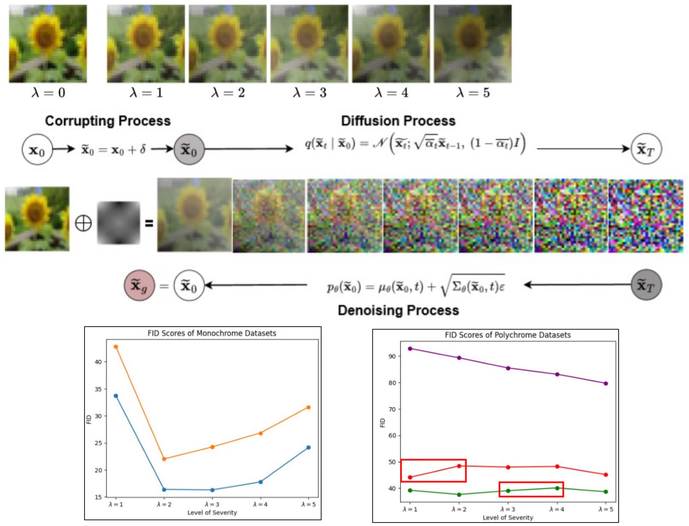
Table 1: FID scores of DDPM/DDIM on the various corruptions

		Clear	Noise		Blur		Weather		Extra
		Identity	Impulse	Shot	Glass	Motion	Brightness	Fog	Spatter
DDPM	MNIST	11.45	5.12	8.91	21.24	16.11	14.93	33.73	13.46
	Fashion MNIST	17.35	14.40	15.91	33.89	25.25	16.53	42.84	18.67
	CIFAR-10	33.53	30.38	23.56	22.39	26.27	35.91	39.23	29.02
	CIFAR-100	44.31	28.76	28.23	25.62	29.82	41.26	44.10	34.60
DDIM	CIFAR-100	70.16	52.33	67.35	61.23	56.88	68.55	71.63	65.60

- DDPM > DDIM >>> WGAN-GP > DCGAN
- Diffusion models are vulnerable to **Fog Corruptions !**

Q2: How much can Fog degrade the performance of the diffusion model?

- Diffusion model was most vulnerable to fog noise
- By increasing its severity, we want to observe the worst result of Diffusion models!



- No significant observation on the result.
- Vulnerability is notably shaped by the correspondence between mean and variance **(fractal structure)**

Q3: Are diffusion models vulnerable to fractal structures?

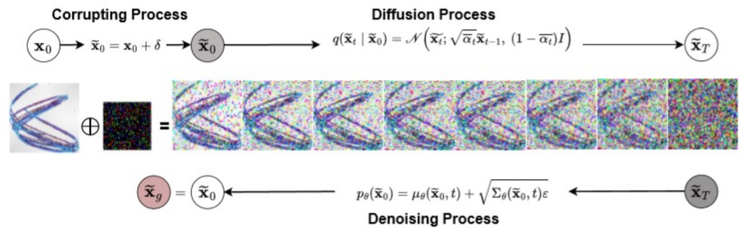


Table 2: FID scores of DDPM on the Fractal Datasets

		Clear	Noise		Blur		Weather		Extra
		Identity	Impulse	Shot	Glass	Motion	Brightness	Fog	Spatter
DDPM	Blue	21.76	9.64	11.90	15.93	14.19	21.86	24.52	23.55
	Red	26.16	14.96	9.86	13.98	22.63	23.96	26.19	18.67
	Green	33.53	30.38	23.56	22.39	26.27	35.91	39.23	29.02
DDIM	Red	95.73	69.05	65.56	85.54	129.46	98.74	99.66	120.71
	Green	80.67	58.51	39.90	51.67	77.39	78.76	88.62	89.20

- No significant vulnerability in generating images with fractal patterns.
- In conclusion, **Exclusive fractal corruption** is vulnerable to diffusion models!